(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
28 March 2002 (28.03.2002)

PCT

(10) International Publication Number
WO 02/24390 A1

(51) International Patent Classification[7]: B23K 1/00, 1/19, 1/20, 101/14, 103/10, F28F 1/30

(21) International Application Number: PCT/JP01/08294

(22) International Filing Date: 25 September 2001 (25.09.2001)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:

2000-289821	25 September 2000 (25.09.2000)	JP
2001-92122	28 March 2001 (28.03.2001)	JP
60/301,848	2 July 2001 (02.07.2001)	JP
2001-265807	3 September 2001 (03.09.2001)	JP

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(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW,

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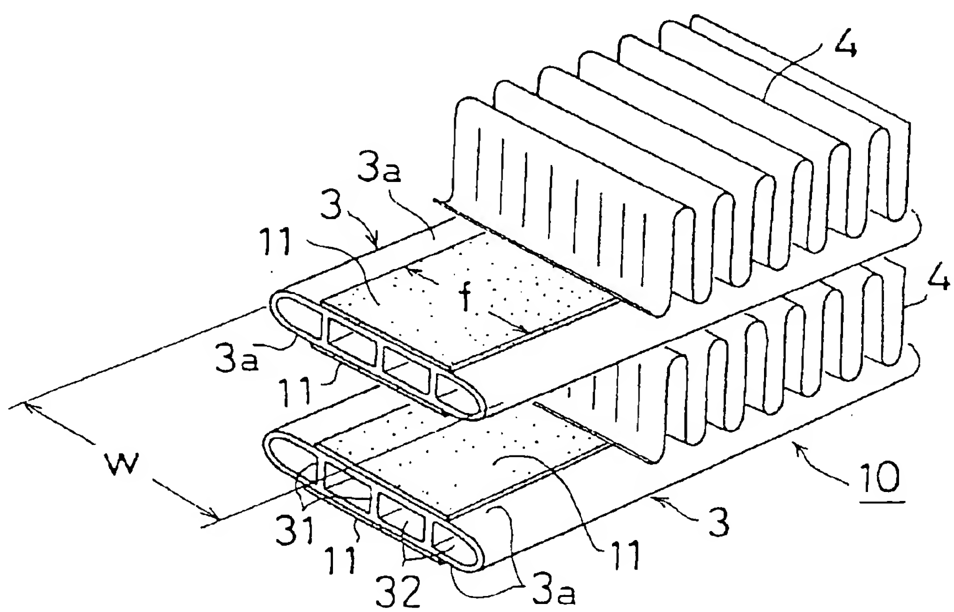
(54) Title: METHOD FOR MANUFACTURING HEAT EXCHANGER



(57) Abstract: Low melting point metal such as Zn is sprayed onto a flat surface (3a) of an aluminum flat tube (3) to form a sprayed metal coating (15) thereon inmediately after extrusion of the flat tube. Inmediately thereafter, a brazing foil (11) is integrally adhered onto the sprayed metal coating (15). The obtained flat tube (3) with the brazing foil is combined with a corrugated fin (4) to form a temporary assembly. Then, the temporary assembly is heated at a predetermined temperature to braze the tube (3) and the fin (4) to thereby form a heat exchanger core. The low melting point metal may be sprayed on both the flat surface (3a) of the flat tube and the surface of the brazing foil (11). Thus, it becomes possible to obtain a lightweight thin fin and to decrease material costs.

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MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *with international search report*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

DESCRIPTION

METHOD FOR MANUFACTURING HEAT EXCHANGER

Cross Reference to Related Applications

This application is an application filed under 35 U.S.C. § 111(a) claiming the benefit pursuant to 35 U.S.C. § 119(e)(1) of the filing data of Provisional Application No.60/301,848 filed on July 2, 2001 pursuant to 35 U.S.C. § 111(b).

Technical Field

The present invention relates to a method for manufacturing a heat exchanger made of aluminum or its alloys (hereinafter simply referred to as "aluminum") such as a condenser, an evaporator and the like for use in automobile, household or office air-conditioning systems.

Background Art

There is a heat exchanger having a heat exchanging core in which fins are disposed between the adjacent heat exchanging tubes. Fig. 1 shows the so-called parallel flow type heat exchanger. In the heat exchanger, a plurality of flat tubes as heat exchanging tubes are disposed in parallel between a pair of parallel headers 1 and 2 with the opposite ends thereof connected to the headers 1 and 2 in fluid communication. Between these flat tubes 3,

corrugated fins 4 are disposed to form a heat exchanging core 10. The heat exchanging medium introduced into one of headers 1 through the inlet 5 provided at the header 1 passes through the heat exchanging core 10 in a meandering manner by the partitions 6 mounted in the headers 1 and 2 while exchanging heat with the ambient air. Then, the heat exchanging medium flows out of the outlet 7. The reference numerals 8 and 9 denote a belt-shaped side plate disposed at the upper and lower ends of the heat exchanging core 10, respectively. In addition to the aforementioned heat exchanger, there are another types of heat exchangers, such as a heat exchanger equipped with flat tubes and plate fins disposed perpendicular to the tubes and a heat exchanger including a serpentine tube bent in a meandering manner as a heat exchanging tube.

Generally, in manufacturing these heat exchangers, components are assembled into a provisional assembly, and then the provisional assembly is subjected to a brazing process in a brazing furnace to integrally join the components. Conventionally, in order to perform the brazing in a brazing furnace, an aluminum flat tube with zinc coating formed by thermally spraying molten zinc onto the external surface of the tube is used as a heat exchanging tube, and a fin comprising an aluminum base member and a brazing coating covering the entire surface thereof are used. The flat tube and the fin are brazed in a brazing furnace. According to another manufacturing method, an aluminum bare member with no clad brazing material is used as a fin, and powder-brazing materials are applied

to the joining portions of the flat tube and the fin. Then, brazing is performed.

According to the aforementioned fin made of brazing materials, there is an advantage that even if the fin is complicated in configuration and has many joining portions like a corrugated fin it is possible to braze it to the flat tube efficiently at one time. However, the total joining area of the portions to be joined is very small and that brazing materials are provided on the entire surface of the fin. Accordingly, excessive brazing materials are consumed, resulting in increased material costs and increased weight. Furthermore, at the time of brazing in a brazing furnace, the base metal of the fin may be eroded by the brazing materials, causing deformation thereof. Since this deformation should be prevented, it was difficult to reduce the thickness of the base metal, resulting in increased fin weight, which in turn makes it difficult to reduce the weight of the heat exchanger. On the other hand, according to the method in which powder-brazing materials are supplied to joining portions of the flat tubes and the fins to form a brazing coating, it takes a time to apply the brazing materials. Furthermore, it is difficult to control the grain size and the thickness of the coating, resulting in uneven thickness of the coating, which in turn causes poor joined portions, partial erosion, etc.

In view of the aforementioned drawbacks, the present invention has been proposed.

It is an object of the present invention to provide a method for manufacturing a heat exchanger which can reduce weight and thickness of a fin constituting a heat exchanging core and material costs thereof.

It is another object of the present invention to provide a method for manufacturing a heat exchanger which can prevent deformation of the fin due to the erosion thereof caused by brazing materials at the time of brazing in a brazing furnace.

It is still another object of the present invention to provide a method for manufacturing a heat exchanger which can improve the assembly handling.

It is still yet another object of the present invention to provide a method for manufacturing a heat exchanger which can reduce weight and manufacturing costs of the entire heat exchanger.

Disclosure of Invention

According to the first aspect of the present, a method for manufacturing a heat exchanger, comprises the steps of extruding an aluminum material into a flat tube which constitutes a heat exchanging tube, integrally adhering a brazing foil via a sprayed metal coating to a flat surface of the flat tube immediately after extrusion of the flat tube, the sprayed metal coating having a melting point lower than a melting point of the brazing foil, combining the flat tube having the brazing foil with a fin, and heating the flat tube with the brazing foil and the fin to melt

said brazing foil to thereby join the fin to the flat tube.

According to the second aspect of the present, a method for manufacturing a heat exchanger, comprises the steps of extruding an aluminum material into a flat tube which constitutes a heat exchanging tube, supplying a brazing foil to a flat surface of the flat tube immediately after extrusion of the flat tube, thermally spraying metal onto the flat surface of the flat tube and/or a surface of the brazing foil at the time of supplying the brazing foil to the flat surface of the flat tube to form a sprayed metal coating, the metal having a melting point lower than a melting point of the brazing foil, pressing the brazing foil on the flat surface of the flat tube to thereby adhere the brazing foil to the flat tube via the sprayed metal coating, combining the flat tube having the brazing foil with a fin, and heating the flat tube with the brazing foil and the fin to melt the brazing fin to thereby join the flat tube to the fin.

According to the aforementioned former and latter manufacturing methods, the brazing foil which carries out the joining of the aluminum flat tube and the fin constituting a heat exchanging core is adhered to the flat tube whose surface area is much smaller than that of the fin. Furthermore, it is not necessary to attach the brazing foil to the entire surface of the flat tube, but enough to attach the brazing foil to a certain width of the flat tube so that a prescribed joining strength can be secured. Accordingly, as compared with the cases where brazing materials

are applied to a fin, the amount of brazing materials decreases greatly as a whole, resulting in reduced material costs. Furthermore, since there is no concern about deformation and/or breaking of the fin by the erosion thereof due to the brazing materials at the time of brazing the flat tube and the fin, a thin member can be used as the fin. In addition to the decreased amount of brazing materials, this can greatly contribute to reduce the weight of the whole heat exchanger, and can avoid poor dimension and/or poor appearance of the heat exchanger due to deformation of the fin.

Furthermore, in the aforementioned methods, the brazing foil is adhered to the aluminum flat tube as a heat exchanging tube by utilizing the heat of the extruded tube immediately after the extrusion. Furthermore, the brazing foil is adhered to the tube via the low melting point sprayed metal coating. Accordingly, the brazing foil can be adhered assuredly to the tube by utilizing the solidification of the thermally sprayed metal.

To the contrary, in cases where a brazing foil is disposed simply between the flat tube and the fin without being adhered to the surface of the tube, it is necessary to enlarge the width and thickness of the brazing foil from the view point of handling. Accordingly, the amount of brazing materials increases, and it requires a lot of efforts and labors to assemble the heat exchanging core before the brazing in a brazing furnace, resulting in low manufacturing efficiency.

Furthermore, according to the second aspect of the present invention, since the brazing foil is pressed onto the flat surface of the flat tube to thereby adhere the brazing foil to the flat tube via the sprayed coating, the adhering strength of the brazing foil can be fully secured and that the thickness of the sprayed metal coating becomes more even.

It is preferable to use Zn as the low melting point metal to be sprayed. In this case, since the Zn will surely exist on the surface of the flat tube, diffusion of Zn for sacrifice erosion protection can be performed smoothly. Furthermore, since the fin does not come into contact with the Zn directly, erosion of the fin due to Zn can be avoided effectively.

It is preferable that the amount of low fusion metal to be sprayed falls within the range of from 3 g/m^2 to 50 g/m^2. This enables the brazing foil to integrally be adhered to the tube by utilizing the solidification of the low melting point metal, and can assuredly avoid bad influences such as erosion of the fin due to the existence of excessive low melting point metal. Furthermore, in cases where the amount of low fusion metal to be sprayed falls within the range of from 5 g/m^2 to 15 g/m^2, the aforementioned effects can be obtained more assuredly.

As for the width of the brazing foil, it is preferable that the width is one fourth or more of a width of the flat tube. This enables to obtain sufficient joining strength while restraining the amount of brazing materials. It is more preferable that the

width of brazing foil is half or more of a width of the flat tub. This further enhances the joining strength.

It is preferable that a thickness of the brazing foil falls within the range of from 2 to 100 μm. By setting the thickness to this range, enough joining strength can be obtained while reducing the amount of materials constituting the brazing foil. It is more preferable that the thickness of the brazing foil falls within the range of from 2 to 40 μm. By setting the thickness to this range, erosion of the base metal of the heat exchanging tube can be assuredly prevented, resulting in a lightweight heat exchanger.

It is preferable that the brazing foil comprises 5 to 20 wt% of Si, 0 to 5 wt% of Zn, 0 to 0.5 wt% of In, and the balance Al and impurities. This brazing foil enhances the brazing of the aluminum flat tube and the fin as well as the joining strength thereof.

It is preferable that the average diameter of grains constituting the brazing foil is 20 μm or less. This brazing foil also enhances the brazing of the aluminum flat tube and the fin as well as the joining strength thereof.

Brief Description of Drawings

Fig. 1 is a front view showing the so-called parallel flow type heat exchanger as an embodiment of a heat exchanger according to the present invention.

Fig. 2 is a perspective view showing the principal part of

the heat exchanging core of the parallel flow type heat exchanger according to the present invention.

Fig. 3 is a schematic side view showing an example of the adhering method of the brazing foil to the aluminum flat tube in the method for manufacturing the heat exchanger according to the present invention.

Fig. 4 is a schematic side view showing another example of an adhering method of the brazing foil to the tube.

Fig. 5 is a schematic side view showing still another example of an adhering method of the brazing foil to the tube.

Fig. 6 is an enlarged cross-sectional view showing the structure of a portion of the flat tube and a brazing foil adhered thereon.

Best Mode for Carrying Out the Invention

The present invention can be applied to various types of heat exchangers different in tube structure and/or fin structure and equipped with a heat exchanging core including a heat exchanging tube through which heat exchanging medium passes and fins attached thereto. For example, the present invention can be applied to the so-called parallel flow type heat exchanger in which heat exchange medium flows in parallel, the so-called serpentine type heat exchanger having a tube as a heat exchanging tube bent in a serpentine manner and a heat exchanger having plate fins disposed perpendicular to heat exchanging tubes.

The present invention will be explained with reference to the multi-flow type heat exchanger shown in Fig. 1 as an embodiment.

In Fig. 1, the reference numerals 1 and 2 denote a header, respectively, 3 an aluminum flat tube constituting a heat exchanging tube, 4 a corrugated fin, 5 an inlet for heat exchanging medium, 6 a partition wall provided in the header 1 and 2, 7 an outlet for heat exchanging medium, 8 and 9 a side plate, respectively, and 10 a heat exchanging core.

Since the arrangement of these components and the heat-exchange function are the same as those explained in the background art, the explanation will be omitted.

As shown in Fig. 2, in the heat exchanger according to the present invention, the alternatively disposed flat tubes 3 and corrugated fins 4 are brazed by the materials of the brazing foils 11 adhered to both the upper and lower flat surfaces of each flat tube 3. Each flat tube 3 is an aluminum extruded hollow article having longitudinally extending partition walls 31 by which the inner space thereof is partitioned into a plurality of passages 32. The corrugated fin 4 is an aluminum bare member with no clad brazing material. The flat tube 3 and the corrugated fin 4 have almost the same width. In the aforementioned structure, the brazing foil 11 to be used for brazing the flat tube 3 and the corrugated fin 4 is adhered to the flat tube 3 having a surface area much smaller than that of the corrugated fin 4, and is not adhered to the lateral sides of the flat tube 3. Furthermore, the

brazing foil 11 is provided only to the minimum width of the upper and lower flat surfaces 3a and 3a so as to secure a prescribed joining strength. Accordingly, as compared with the cases where brazing materials are applied to the corrugated fin 4, the amount of brazing materials greatly decreases as a whole, resulting in greatly decreased material costs. Furthermore, since the corrugated fin 4 will not be deformed by the erosion due to the brazing materials at the time of brazing the flat tube 3 and the corrugated fin 4, a thinner corrugated fin 4 can be used without causing any problem. Thus, in addition to the decreased amount of brazing materials as mentioned above, the weight of the heat exchanger can be decreased as a whole.

In manufacturing the aforementioned heat exchanger, as shown in Fig. 3, the aluminum flat tube 3 is continuously extruded by an extruding machine 12. At the same time, metallic materials such as Zn having a melting point lower than that of the brazing foil is thermally sprayed onto the upper and lower flat surfaces 3a and 3a of the flat tube 3 through spraying nozzles 14 and 14 at the position immediately after the extrusion.

Subsequently, the brazing foils 11 and 11, which are continuously being supplied in synchronism with the extrusion rate, are adhered onto the brazing coatings by the pressure rolls 13 and 13. As shown in Fig. 4, the thermally spraying of the low melting point metal may be performed to the surfaces of the brazing foils 11 and 11 (the surfaces to be adhered to the tube). Alternatively,

as shown in Fig. 5, the thermally spraying of the low melting point metal may be performed to both the flat surfaces of the flat tube 3 and the inner surfaces of the brazing foils 11 and 11. In these methods, since the flat tube 3 immediately after the extrusion from the extruding machine 12 still holds high temperature, the brazing foils 11 and 11 are adhered when the sprayed metal coatings 15 are in a melting state. Thus, the brazing foils 11 and 11 are adhered to the tube 3 by utilizing the solidification of the sprayed metal.

As the aforementioned thermally spraying metal, various metal having a melting point lower than that of the brazing foil 11 can be used. Although Sn, Zn-Sn alloy, Zn-Al alloy, Al-Si alloy and the like may be used, it is more preferable to use Zn because Zn diffuses into the surface of the tube to form a good sacrifice erosion protection layer.

Too small spraying amount of the low melting point metal may cause inadequate joining strength of the foil 11. On the other hand, too much spraying amount thereof will waist the material costs. Especially, too much spraying amount of Zn may cause erosion of the fin. Accordingly, the spraying amount should fall within the range of from 3 g/m^2 to 50 g/m^2. It is preferable that the spraying amount falls within the range of from about 5 g/m^2 to about 15 g/m^2. In cases where the thermal spraying is performed to both the flat surface 3a of the tube 3 and the surface of the brazing foil 11, the aforementioned spraying amount denotes the total amount of the sprayed metal on the tube 3 and the brazing foil 11.

In the present invention, the brazing foil 11 is made by forming brazing materials into a foil. For example, the brazing foil 11 can be easily formed by directly supplying melting brazing materials to a rolling mill to obtain a foil having a prescribed thickness, or to obtain a foil having a thickness larger than the prescribed thickness and then obtain a foil having the prescribed thickness by applying heat rolling or cold rolling. It is preferable that the thickness of the brazing foil 11 falls within the range of from 2 to 100 μm, and more preferable that the thickness of the brazing foil 11 falls within the range of from 2 to 40 μm. When the thickness is smaller than 2 μm, it becomes difficult to obtain sufficient joining strength. On the other hand, when the thickness is larger than 100 μm, the base metal of the heat exchanging tube may be eroded at the time of brazing in a brazing furnace. When the thickness is set to fall within the range of from 2 to 40 μm, the whole heat exchanger can be greatly decreased in weight. The brazing foil 11 is preferably made of aluminum alloys such as Al-Si alloy, Al-Si-Zn alloy and Al-Si-In alloy. In order to obtain good brazing nature and good joining strength, it is recommended to use aluminum alloys comprising 5 to 20 wt% of Si, 0 to 5 wt% of Zn, 0 to 0.5 wt% of In, and the balance Al and inevitable impurities. Furthermore, it is preferable that an average diameter of grains constituting the brazing materials is 20 μm or less. When the grain is too large, the brazing foil does not melt uniformly at the time of brazing, which causes deterioration of brazing nature.

Furthermore, it becomes difficult to manufacture a thin foil.

It is preferable that the width f of the brazing foil 11 is one fourth or more of the width W of the flat tube 3 (see Fig. 2). More preferably, the width f of the brazing foil is one third or more of the width W of the flat tube 3. The optimal width f is half or more of the width W of the flat tube 3. When this width f is smaller than one fourth of the tube width W, sufficient brazing cannot be performed. When the width f is half or more of the width W of the tube 3, sufficient brazing can be performed regardless of dimensional tolerance of components.

The extruded flat tubular element on which the brazing foils 11 and 11 are adhered is cut into a plurality of flat tubes 3 as heat exchanging tubes each having a certain length. These flat tubes 3 are combined with fins 4 which are aluminum bare members with no brazing material into a provisional heat exchanging core 10. Then, this provisional heat exchanging core 10 is heated in a brazing furnace to thereby braze the flat tubes 3 and the fins 4 by the melting brazing materials of the brazing foil 11.

In the aforementioned brazing in a brazing furnace, it is recommended that another components, for example, the headers 1 and 2, the inlet pipe 5, the partitions 6, the outlet pipe 7, the side plates 8 and 9, etc., in the parallel flow type heat exchanger as shown in Fig. 1, are assembled together with the tubes 3 and the fins 4 into a provisionally assembled heat exchanger, and then this provisionally assembled heat exchanger is brazed in a furnace

at the same time. The aforementioned another components may be made of materials having brazing materials. Alternatively, the aforementioned another components may be brazed by brazing materials only disposed at the joining portions thereof. However, as for the side plates 8 and 9, it is preferable that the side plate is made of a brazing member or a member having brazing coating like the aforementioned flat tube 3.

<Examples>

Examples 1 to 8

As shown in Fig. 3, on both the upper and lower flat surfaces of the aluminum flat tube 3 which was being continuously extruded from the extruding machine 12, Zn was thermally sprayed from the nozzles 14 and 14 located at the position immediately after the extrusion to form sprayed metal coatings 15 and 15. Immediately after the formation of the sprayed metal coatings 15 and 15, brazing foils 11 and 11 made of Al-Si alloy (comprising: 8 wt% of Si; and the balance Al and impurities) were adhered on the sprayed metal coatings 15 and 15 by using pressure rollers 13 and 13. Thus, a flat tube 3 on which brazing foils 11 and 11 were adhered was obtained.

The aforementioned flat tube 3 was manufactured by extruding AA 1100 aluminum alloy at the extrusion rate of 50 m/min and the temperature of 450 °C into a flat tube having a width W of 16 mm, a thickness (height) of 1.6 mm, a wall thickness of 0.3 mm and four follow portions.

The spraying of Zn was performed under the conditions of the nozzle angle of 30 degrees and the distance of 150 mm while changing the spraying mount as shown in Table 1 within the range of from 5 to 50 g/m^2.

As for the brazing foil 11, the thickness and the ratio of the width to the tube width W were changed variously as shown in Table 1 within the range of from 10 to 50 µm and the range of from 30 to 80 %, respectively.

Then, flat tubes 3 with the brazing foils 11 each having a predetermined length and corrugated fins 4 made of 3003 aluminum alloy bare member and having a thickness of 0.1 mm were stacked one on the other to assemble a provisional heat exchanging core 10. Furthermore, the headers 1 and 2, the inlet pipe 5, the partitions 6, the outlet pipe 7, the side plates 8 and 9 were also assembled together with the provisional heat exchanging core 10. Then, this assembly was brazed in a furnace to obtain the so-called parallel flow type heat exchanger.

<Examples 9 and 10>

As the spraying metal to be thermally sprayed onto the upper and lower surfaces of the flat tube 3 immediately after the extrusion, in place of Zn used in the aforementioned examples 1 to 8, Zn-Sn alloy was used. The other conditions were the same as in the example 2. Thus, the so-called parallel flow type heat exchanger was manufactured.

<Example 11>

As the materials of the brazing foil, Al-Si-Zn alloy (comprising: 8 wt% of Si; 3 wt% of Zn; and the balance Al and impurities) was employed. The other conditions were the same as in the example 6. Thus, the so-called parallel flow type heat exchanger was manufactured.

<Example 12>

As the materials of the brazing foil, Al-Si-Zn alloy (comprising: 8 wt% of Si; 5 wt% of Zn; and the balance Al and impurities) was employed. The other conditions were the same as in the example 6. Thus, the so-called parallel flow type heat exchanger was manufactured.

<Example 13>

As the materials of the brazing foil, Al-Si alloy (comprising: 13 wt% of Si; and the balance Al and impurities) was employed. The other conditions were the same as in the example 6. Thus, the so-called parallel flow type heat exchanger was manufactured.

<Example 14>

As the materials of the brazing foil, Al-Si alloy (comprising: 20 wt% of Si; and the balance Al and impurities) was employed. The other conditions were the same as in the example 6. Thus, the so-called parallel flow type heat exchanger was manufactured.

<Comparative examples 1 to 3>

On both the upper and lower flat surfaces of the aluminum flat tube 3 immediately after the extrusion, an excessive amount of Zn ($100\ g/m^2$, $200\ g/m^2$) was thermally sprayed. Immediately after the

spraying, brazing foils 11 were adhered by pressing. Thus, tubes with brazing foils were obtained (comparative examples 1 and 2). On the other hand, on both the upper and lower flat surfaces of the aluminum flat tube 3 immediately after the extrusion, no Zn was thermally sprayed. Immediately after the extrusion, brazing foils 11 were adhered by pressing. Thus, a tube with brazing foils were obtained (comparative example 3). Then, by using the aforementioned flat tube, heat exchanges were manufactured/were tried to manufacture in the same manner as in the example 2.

<Comparative examples 4 to 6>

As the materials of the brazing foil, brazing foils including the compositions shown in Table 1 were employed. The other conditions were the same as in the example 6. Thus, the so-called parallel flow type heat exchangers were manufactured or tried to manufacture.

About the heat exchangers obtained according to the aforementioned examples and comparative examples, the set yield of the brazing foil, the yield (dropping of brazing foil) at the time of heating, the brazing nature and the existence of erosion were examined. The results are shown in Table 2. The evaluation method of each item is as follows.

[Set yield]

It was examined whether or not the brazing foils were set at the predetermined position in a provisional assembly of the flat tubes and the corrugated fins. The ratio of the assembly in which

the brazing foils were set correctly is shown in Table 2.

[Yield (dropping of brazing foil) at the time of heating]

A miniature heat exchanging core sample of each heat exchanger was disposed in a brazing furnace at the temperature of 540 °C for 15 minutes. Then, it was examined whether or not the brazing foil was dropped off, and the ratio of the sample in which the brazing foil was not dropped off is shown in Table 2.

[Brazing nature]

The brazed rate of the corrugated fin was examined.

[Existence of erosion]

About both the fin side and the tube side, it was examined whether there is erosion after the brazing. In Table 2, "Yes" denotes that erosion of 30 μm or more exists, and "No" denotes that erosion of less than 30 μm exists.

Table 1

		Sprayed metal coating		Brazing foil		
		Metal	Sprayed amount(g/m^2)	Metal	Thickness (μm)	Width (%)
Example	1	Zn	5	Al-8%Si	10	80
	2	Zn	10	Al-8%Si	20	80
	3	Zn	20	Al-8%Si	50	80
	4	Zn	10	Al-8%Si	20	50
	5	Zn	10	Al-8%Si	20	30
	6	Zn	20	Al-8%Si	20	80
	7	Zn	30	Al-8%Si	20	80
	8	Zn	50	Al-8%Si	20	80
	9	Zn-10%Sn	10	Al-8%Si	20	80
	10	Zn-50%Sn	10	Al-8%Si	20	80
	11	Zn	20	Al-8%Si-3%Zn	20	80
	12	Zn	20	Al-8%Si-5%Zn	20	80
	13	Zn	20	Al-13%Si	20	80
	14	Zn	20	Al-20%Si	20	80
Comparative Example	1	Zn	100	Al-8%Si	20	80
	2	Zn	200	Al-8%Si	20	80
	3	Zn	0	Al-8%Si	20	80
	4	Zn	20	Al-4%Si	20	80
	5	Zn	20	Al-8%Si-7%Zn	20	80
	6	Zn	20	Al-25%Si	20	80

Table 2

		Yield		Brazed rate	Erosion	
		Set(%)	Heating(%)	(%)	Fin	Tube
Example	1	100	100	100	No	No
	2	100	100	100	No	No
	3	100	100	100	No	No
	4	100	100	100	No	No
	5	100	100	100	No	No
	6	100	100	100	No	No
	7	100	100	100	No	No
	8	100	100	100	No	No
	9	100	100	100	No	No
	10	100	100	100	No	No
	11	100	100	100	No	No
	12	100	100	100	No	No
	13	100	100	100	No	No
	14	100	100	100	No	No
Comparative Example	1	100	100	100	Yes	Yes
	2	100	100	60 (Note 1)	Yes	Yes
	3	72 (Note 2)	64 (Note 2)	35 (Note 2)	No	No
	4	100	100	80 (Note 3)	No	No
	5	100	100	100 (Note 4)	Yes	Yes
	6	100	100	100 (Note 4)	Yes	Yes

Note 1: Fins are melt due to the erosion to cause poor joining. At the same time, fins are broken.

Note 2: Evaluated among 100 sets (at the time of set), 72 sets (i.e., 46/72=64% at the time of heating) and 46 sets (Brazed rate), respectively.

Note 3: Joint was poor because the brazing foil did not melt enough.

Note 4: Although there was no problem as to the brazing rate, deformation was occurred due to heavy erosion.

As mentioned above, in the present invention, a brazing foil is adhered to an aluminum flat tube, and the flat tube and a fin are brazed by the brazing foil. Therefore, the amount of brazing materials to be used in a heat exchanging core can be greatly decreased. Furthermore, even in cases where the fin is thin, the fin will not be deformed by the erosion due to the brazing materials, resulting in greatly reduced material costs, a lightweight heat exchanging core and enhanced handling of assembly.

Furthermore, a brazing foil is adhered on the flat surface of the flat tube immediately after the extrusion via a sprayed metal coating having a melting point lower than that of the brazing foil, and the brazing foil is adhered to the flat tube by utilizing the solidification of the sprayed metal. Accordingly, the brazing foil can be integrally adhered to the outer surface of the flat tube assuredly with enough joining strength while utilizing the heat of the extruded tube immediately after the extrusion. Thus, the displacing or dropping of the foil at the time of assembling the heat exchanging core and/or at the time of brazing can be prevented, resulting in enhanced manufacturing yield of a heat exchanger with no dimensional fault and/or good appearance.

The joining portion on the surface of the flat tube to be joined to a fin is covered by a brazing foil having a smooth surface which is more smooth as compared with the surface of the sprayed metal coating. Therefore, the setting of the fin to the tube can be easily performed.

In cases where Zn is used as the aforementioned thermally spraying metal, a sacrifice erosion protection layer due to the diffusion of Zn can be formed. Furthermore, since the fin does not come into contact with the Zn directly, erosion of the fin due to Zn can be avoided effectively, which can prevent a poor dimension of the heat exchanger due to deformation of the fins and a poor appearance thereof.

In cases where the amount of low fusion materials to be thermally sprayed falls within the range of from 3 g/m^2 to 50 g/m^2, the brazing foil can be adhered to the tube assuredly and can assuredly avoid erosion of the fin due to the existence of excessive low melting point metal. Furthermore, in cases where the amount of low melting point materials to be thermally sprayed falls within the range of from 5 g/m^2 to 15 g/m^2, the aforementioned effect can be obtained more certainly.

In cases where the width of the brazing foil is one fourth or more of a width of the flat tube, enough joining strength can be obtained while restraining the amount of brazing materials. Furthermore, in cases where the width of brazing foil is half or more of a width of the flat tub, more enhanced joining strength can be obtained.

In cases where the thickness of the brazing foil falls within the range of from 2 to 100 μm, enough joining strength can be obtained while restraining the amount of brazing materials. Furthermore, in cases the thickness of the brazing foil falls within the range

of from 2 to 40 μm, erosion of the base metal of the heat exchanging tube can be assuredly prevented while obtaining sufficient strength, and a lightweight heat exchanger can be obtained.

In cases where the brazing foil comprises 5 to 20 wt% of Si, 0 to 5 wt% of Zn, 0 to 0.5 wt% of In, and the balance Al and impurities, good brazing performance of the tube and the fin and excellent joining strength thereof can be obtained.

In cases where the average diameter of grains constituting the brazing foil is 20 μm or less, good brazing performance of the tube and the fin and excellent joining strength thereof can be obtained.

This application claims priority to Japanese Patent Applications Nos. 2000-289821 filed on September 25, 2000, 2001-92122 filed on March 28, 2001 and 2001-265807 filed on September 3, 2001, the disclosure of which is incorporated by reference in its entirety.

The terms and descriptions in this specification are used only for explanatory purposes and the present invention is not limited to these terms and descriptions. It should be appreciated that there are many modifications and substitutions without departing from the spirit and the scope of the present invention which is defined by the appended claims. A present invention permits any design-change, unless it deviates from the soul, if it is within the limits by which the claim was performed.

Industrial Applicability

The method of manufacturing a heat exchanger according to the present invention can be applied to a method of manufacturing an aluminum heat exchanger as a condenser or an evaporator for an automobile, household or office air conditioning system because the fin constituting the heat exchanging core can be lighter and thinner and the material costs can be decreased.

CLAIMS

1. A method for manufacturing a heat exchanger, comprising the steps of:

extruding an aluminum material into a flat tube which constitutes a heat exchanging tube;

integrally adhering a brazing foil via a sprayed metal coating to a flat surface of said flat tube immediately after extrusion of said flat tube, said sprayed metal coating having a melting point lower than a melting point of said brazing foil;

combining said flat tube having said brazing foil with a fin; and

heating said flat tube having said brazing foil and said fin to melt said brazing foil to thereby join said fin to said flat tube.

2. A method for manufacturing a heat exchanger, comprising the steps of:

extruding an aluminum material into a flat tube which constitutes a heat exchanging tube;

supplying a brazing foil to a flat surface of said flat tube immediately after extrusion of said flat tube;

spraying metal onto said flat surface of said flat tube and/or a surface of said brazing foil at the time of supplying said brazing foil to said flat surface of said flat tube to form a sprayed metal

coating, said metal having a melting point lower than a melting point of said brazing foil;

pressing said brazing foil on said flat surface of said flat tube to thereby adhere said brazing foil to said flat tube via said sprayed metal coating;

combining said flat tube having said brazing foil with a fin; and

heating said flat tube having said brazing foil and said fin to melt said brazing foil to thereby join said flat tube to said fin.

3. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein Zn is used as said metal to be sprayed.

4. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein an amount of said metal to be sprayed falls within the range of from 3 g/m^2 to 50 g/m^2.

5. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein an amount of said metal to be sprayed falls within the range of from 5 g/m^2 to 15 g/m^2.

6. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein a width of said brazing foil is one fourth or more of a width of said flat tube.

7. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein a width of said brazing foil is half or more of a width of said flat tube.

8. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein a thickness of said brazing foil falls within the range of from 2 to 100 μm.

9. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein a thickness of said brazing foil falls within the range of from 2 to 40 μm.

10. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein said brazing foil comprises:

5 to 20 wt% of Si;

0 to 5 wt% of Zn;

0 to 0.5 wt% of In; and

the balance Al and impurities.

11. The method for manufacturing a heat exchanger as recited in claim 1 or 2, wherein an average diameter of grains constituting said brazing foil is 20 μm or less.

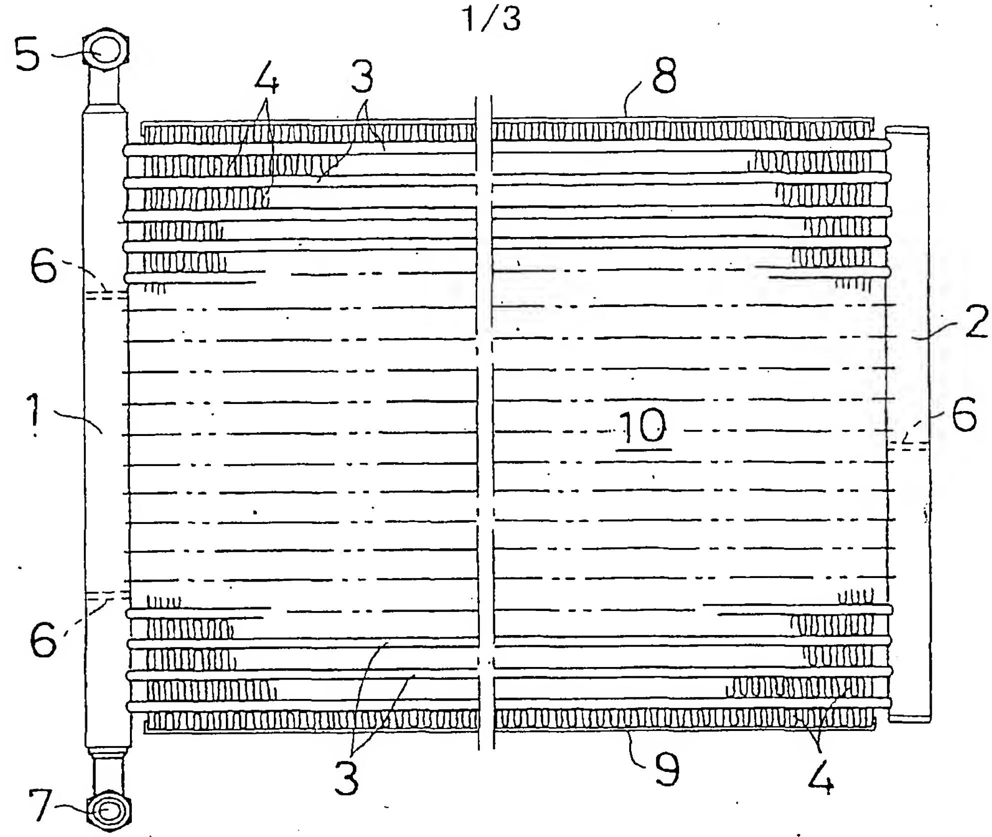

FIG.1

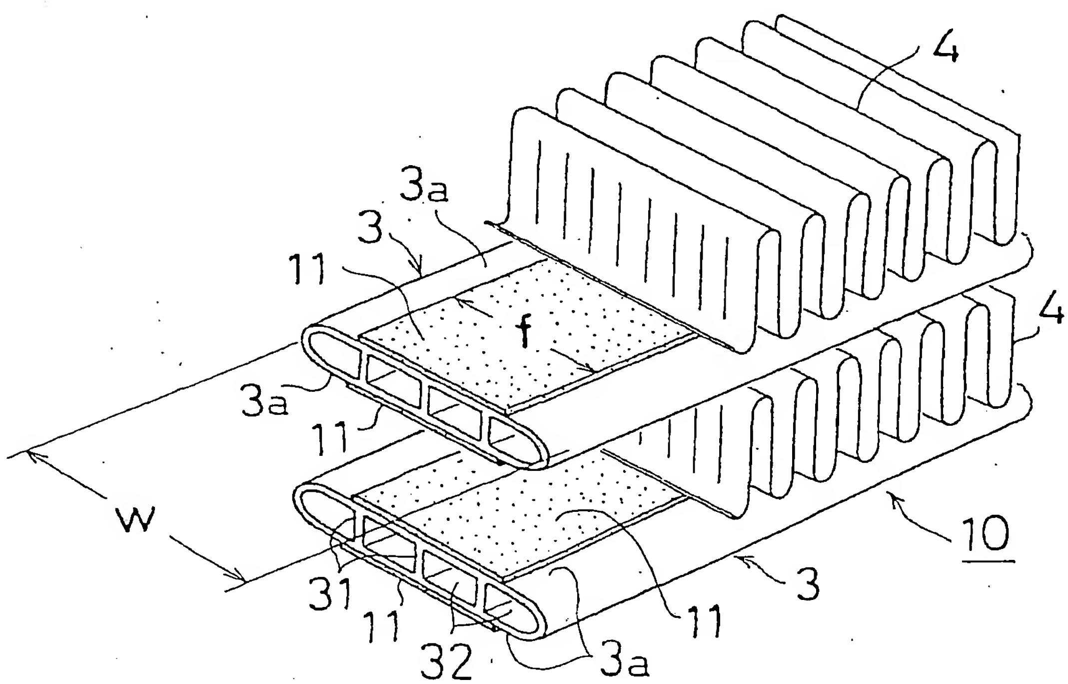

FIG.2

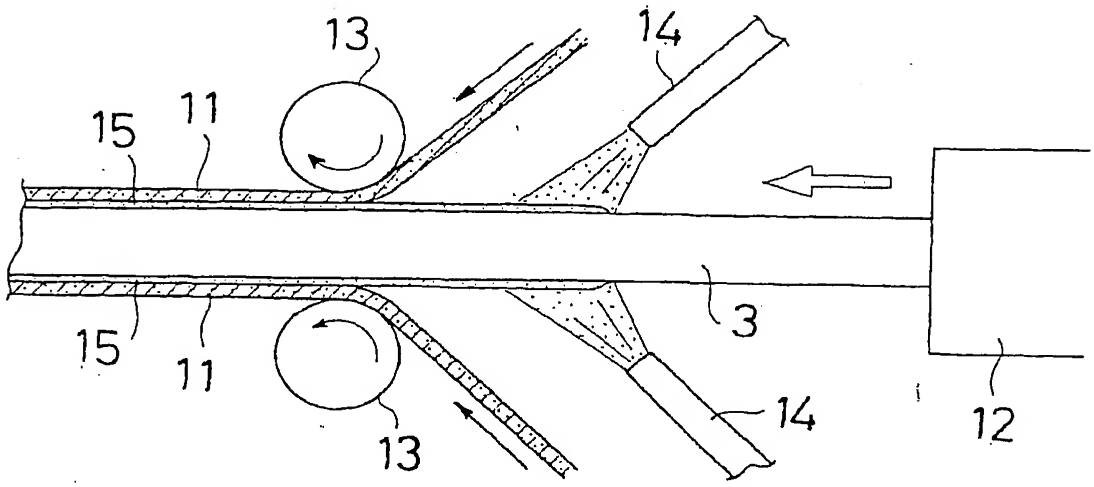

FIG.3

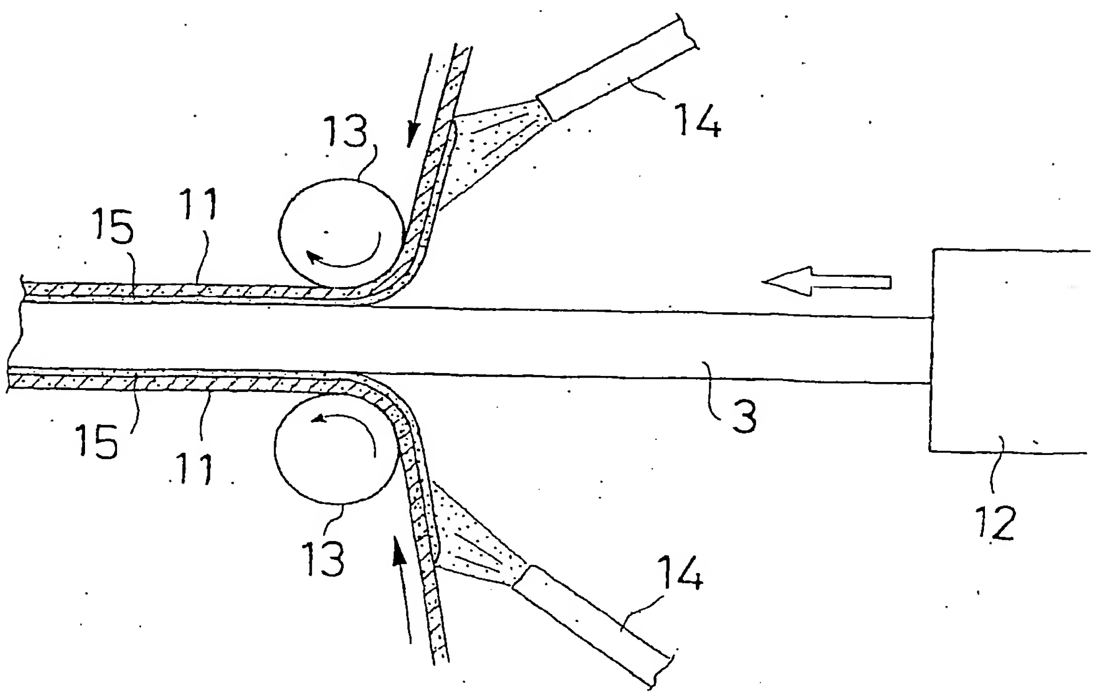

FIG.4

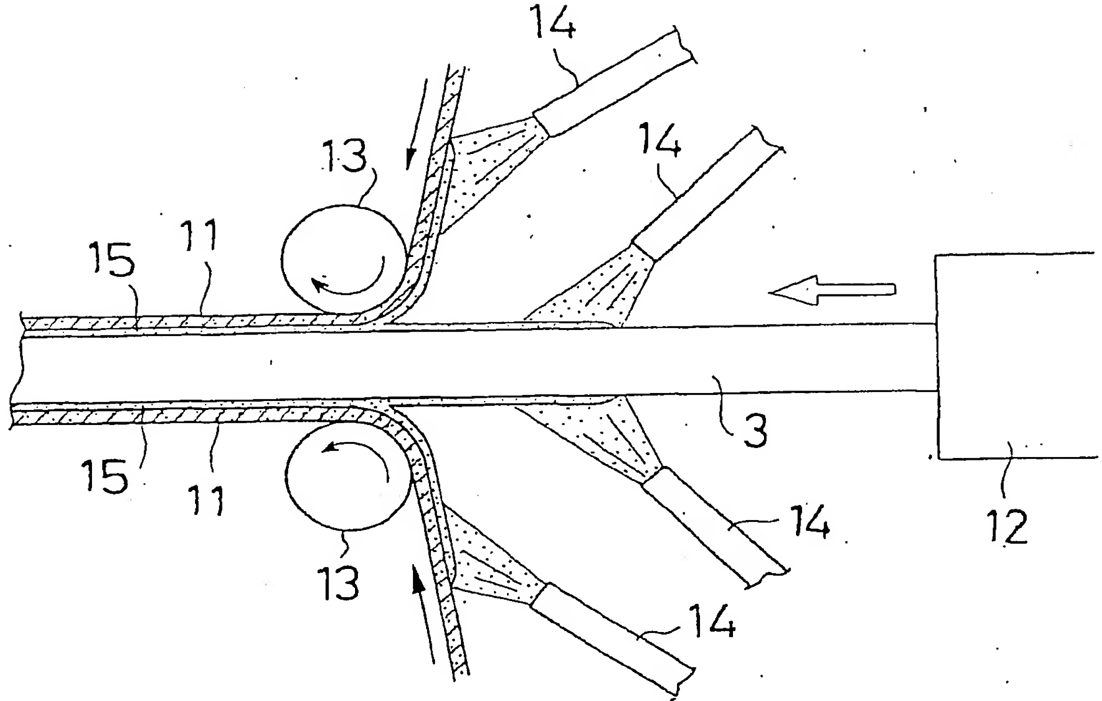

FIG.5

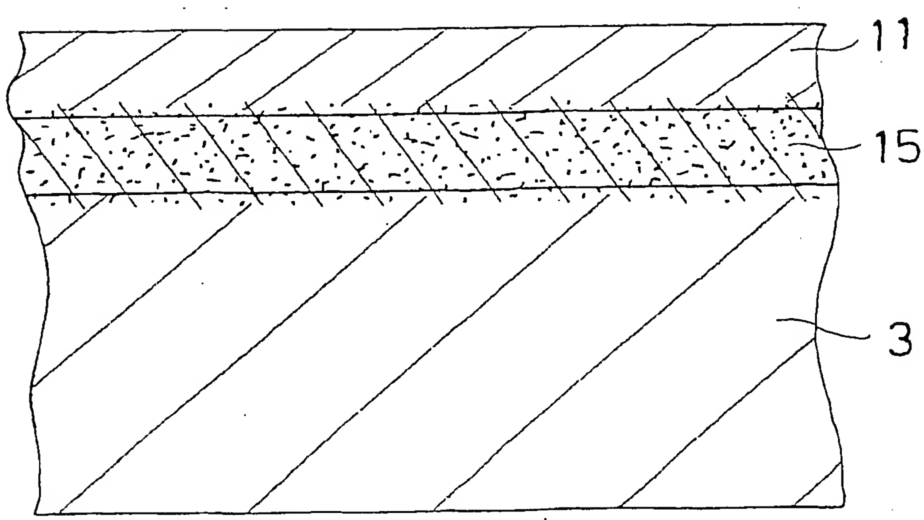

FIG.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP01/08294

A. CLASSIFICATION OF SUBJECT MATTER

Int.Cl[7] B23K1/00 , B23K1/19 , B23K1/20 , B23K101:14 , B23K103:10 , F28F1/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] B23K1/00 , B23K1/19 , B23K1/20 , B23K101:14 , B23K103:10 , F28F1/30

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Japanese Utility Model Gazette 1926-1996, Japanese Publication of Unexamined Utility Model Applications 1971-2001, Japanese Registered Utility Model Gazette 1994-2001, Japanese Gazette Containing the Utility Model 1996-2001

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
PX	JP 2000-274980 A(Denso K.K.)6 October 2000(06.10.00), Column 5 Line 17-25, Column 5 Line 49 - Column 6 Line 9, Column 6 Line 26-36, Fig 4 (Family:none)	1,3-7,10
Y	JP 2-46969 A(Furukawa Aluminum Industrial K.K.)16 February 1990(16.02.90), Claims 1, Page 2,lower right column,Line 7-8, Fig 2 (Family:none)	1-11

☑ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier application or patent but published on or after the international filing date
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- "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
- "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
- "&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
17.12.01	25.12.01

Name and mailing address of the ISA/JP	Authorized officer
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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 61-71172 A(Nippon Denso K.K.)12 April 1986(12.04.86), Claims 1,4, Page 3,lower left column,Line 9-20, Page 4,upper left column,Line 2-6, Fig 3 (Family:none)	1-11
Y	JP 3-281096 A(Toshiba K.K.)11 December 1991(11.12.91), Claims 1-3 (Family:none)	1-11
Y	JP 63-140731 A(Showa Aluminum K.K.)13 June 1988(13.06.88), Claims 1-2, Fig 2 (Family:none)	1-11